Space Vehicle to Save Launch Costs

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205–544–2615

High launch costs, resulting from the weight and fuel required to deliver a satellite to the proper orbit, are a prohibiting factor in the commercial satellite industry. If additional thrust could be created once in space, less fuel would be required, thereby also reducing weight factors.

Under the Aerospace Industry Technology Program, an industry, academia, and government consortium was formed on April 24, 1995, to develop a new space vehicle to save on launch costs. The consortium, led by McDonnell Douglas Aerospace in Huntington Beach, California, includes United Applied Technologies in Huntsville, Alabama; Thiokol Corporation in Brigham City, Utah; the University of Alabama in Huntsville, Huntsville, Alabama; the U.S. Air Force Phillips Laboratory at Edwards Air Force Base, California; Lewis Research Center in Cleveland, Ohio; and MSFC.

The consortium's goal is to develop a Solar Thermal Upper Stage (fig. 116)—a space vehicle with a unique propulsion system. The planned propulsion system uses large concentrating mirrors to focus sunlight on an energy-absorbing engine. The engine heats hydrogen propellant to high temperatures and releases it through a nozzle to create thrust. Once developed, the system can efficiently transport satellites from low-Earth orbit to geosynchronous equatorial orbit in 15 to 30 days. For communication and Earth-sensing satellites, the geosynchronous orbit is preferred because satellites orbit together with the Earth's rotation and appear to be stationary points over the Earth's surface. The propulsion efficiency of the Solar Thermal Upper Stage allows it to transfer satellites about twice as large as chemical-propulsion (hydrogen/oxygen) transfer vehicles. This, in turn, enables satellite owners to use a smaller, less costly, expendable launch vehicle for the same payload, resulting in a significant cost savings of up to $150 million per launch.

Single-stage-to-orbit vehicles, as currently envisioned, have no capability to place satellites in geosynchronous transfer orbit or in geosynchronous equatorial orbit; the Solar Thermal Upper Stage can provide this capability. Its development will enable the U.S. commercial expendable launch vehicle business to be more cost-competitive

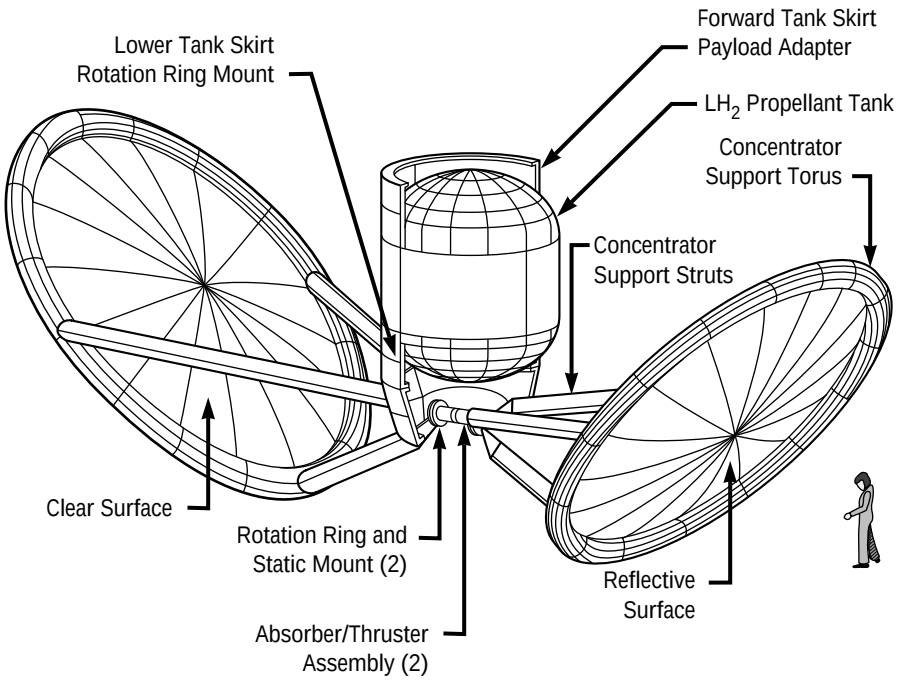

FIGURE 116.—The Solar Thermal Upper Stage uses large, inflatable, parabolic concentrators to focus sunlight on a high-temperature absorber. The absorber is cooled by heating hydrogen gas circulating through it. The hot (2,600-Kelvin) hydrogen is expanded through a nozzle to provide thrust (1 to 10 pounds) at high specific impulse (800 to 1,000 seconds). The fuel is stored as subcritical liquid hydrogen. The Solar Thermal Upper Stage is autonomously guided as it requires about 130 burns (orbits) on its 30-day transfer mission from low-Earth orbit to geosynchronous equatorial orbit.

with the French, Russian, or Chinese launchers.

The roles of the consortium member are as follows: McDonnell Douglas provides consortium/program management, system design and integration, and liquid-hydrogen storage/feed-system development; United Applied Technologies manages concentrator development; Thiokol Corporation provides concentrator support development; MSFC leads absorber/engine development and testing of the hydrogen storage/feed system; Lewis Research Center develops the flight-type hydrogen tank; the U.S. Air Force's Phillips Laboratory undertakes the testing of the concentrator, absorber/engine; and the University of Alabama in Huntsville conducts data analysis and diagnostics.

The program is valued around $2.65 million, which is a 50-percent cost-share by industry over 30 months beginning in April 1995. Although many of the technologies have been demonstrated at the component level by one of the partnership members, no system demonstration of these various elements together has been demonstrated (on ground or in space), as the capabilities are spread across a number of entities.

Sponsors: NASA Jet Propulsion Laboratory; Office of Technology Transfer

Industry Involvement: McDonnell Douglas Aerospace, Huntington Beach, California; United Applied Technologies, Huntsville, Alabama; Thiokol Corporation, Brigham City, Utah

University Involvement: University of Alabama in Huntsville, Huntsville, Alabama

Other Government Involvement: Phillips Laboratory, Edwards Air Force Base, California; Lewis Research Center, Cleveland, Ohio